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ABSTRACT

Outlined is an approach to designing programs and institutions for the whole range of TETs (Technology Exchange Transactions) to serve particular developing nations, economic sectors, technical fields, or geographic regions. Personal factors such as needs, capabilities, and attitudes of the user, as well as formal economic and organizational factors, influence the design approach. The design model for TETs contains three elements: (1) design features--what can we manipulate? (2) design criteria--what do we want to accomplish? and (3) design parameters--what must we accept as given? This approach is intended to have a major impact on the survival of a TET program as well as on its usefulness to countries and individuals. (Author/STS)

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PROGRAM OF RESEARCH ON THE MANAGEMENT

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DESIGNING ORGANIZATIONS FOR INTEGRATING TECHNOLOGY EXCHANGE TRANSACTIONS (TETs) IN DEVELOPING COUNTRIES

Albert H. Rubenstein

January, 1976

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1. INTRODUCTION: THE CONCEPT OF TECHNOLOGY EXCHANGE TRANSACTIONS (TETs)

In a recent paper[1] the concept of an integrated approach to a wide range of idea, technology, and information exchanges was presented. The term "Technology Exchange Transaction" (TET) was used to describe the set of interactions generally covered separately under the headings of: Scientific and Technical Information (STI), Technical Assistance (TA), and Technology Transfer (TT). In that paper a number of issues and questions pertinent to the field were raised and some suggestions were given as to possible experimental approaches to addressing them, using the techniques of in-house or administrative experimentation.

In an earlier paper[2] a number of ideas were put forth on the marketing of STI and related technical information in LDCs. This paper builds on both of these earlier ones and outlines an approach to designing programs and institutions for the whole range of TETs to serve particular countries, economic sectors, technical fields, or geographic regions in LDCs.

The major points raised in the previous papers included: the need for integration of the wide range of TETs, the nature of the facilities and skills required, the problems of pricing and marketing, and the institutional characterisitics required to make them successful.

In addition to the two previous papers and our general work in this area at Northwestern University in the Program of Research on The Management

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1. Albert H. Rubenstein, "Technical Information, Technical Assistance, and Technology Transfer - The Need for a Synthesis," presented to the Seminar on the Managment of the Transfer of Technology within Industrial Cooperation, Sponsored by the United Nations Economic Commission for Europe, Geneva, July,1975.

2. Albert H. Rubenstein, "Idea for a Research Design or an Administrative Experiment on Marketing of Scientific and Technical Information in Developing Countries," November, 1974.

of Research and Development (POMRAD),[3] ideas for this paper come from a methodology study we did for OAS several years ago[4] as part of a multi-country program on Technology Transfer in Latin America.[5]

In all of this work, we have emphasized the needs, capabilities, attitudes, and situation of the user of technological ideas and information. That is, we have been concerned with how he perceives and acts upon his needs and opportunities for acquiring and using such inputs. This has, of course, raised the question of the importance, to the variety of people we generally consider to be customers or clients for TETs, of such things as: costs, benefits, importance of an "adequate" vs. a "perfect" or complete answer, timeliness, form, interpersonal relations, individual style, and so on. These TETs are not merely mechanistic, impersonal exchanges between formal organizations; they also involve the feelings, aspirations, self-respect, suspicions, sentiments toward others, and other very personal aspects of the people involved. Therefore, when we discuss (below) the question of how to effectively design TET programs and procedures, these personal factors will weigh heavily, along with the formal economic and organizational factors.

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3. Albert H. Rubenstein and Gustave Rath, "Some Preliminary Experiments and a Model of Information-Seeking Style of Researchers," Proceedings of National Conference on The Administration of Research, October, 1966.

Albert H. Rubenstein, William Buel, Daniel Kegan, et al., "Explorations on the Information-Seeking Style of Researchers," in C.E.Nelson and D.K. Pollock (eds.), Communication Among Scientists and Engineers, D.C.Heath, 1970.

Albert H. Rubenstein, Gustave Rath, Robert O'Keefe, et al., "Behavioral Factors Influencing the Adoption of an Experimental Information System," Hospital Administration, Vol. 18, No. 4, Fall,1973.

Albert H. Rubenstein, Charles W. N. Thompson, and Robert D. O'Keefe, "Analysis of Critical Issues in the Transfer of Scientific and Technical Information," Progress Report No. 5 to OSIS/NSF, October, 1975.

4. Albert H. Rubenstein, William Davig, Allen Jedlicka, and Enrique Ogliastri, "Study of Technology Diffusion in Latin America: Methodology Phase," December, 1970.

5. Final Report on: "Programa Regional de Desarrollo Científico y Tecnológico, Departamento de Asuntos Científicos, Secretaría General de la Organización de los Estados Americanos, Produccion, Transferencis y Adaptacion de Tecnologia Industrial, Estudios Sobre el Desarrollo Científico y Tecnológico, No. 11, Washington, 1974.

2. THE POSSIBILITY OF INTEGRATED TET PROGRAMS AND FACILITIES

In the two recent papers mentioned, there is thought given to the possibility of highly integrated networks of people and information facilities in a country or region that could provide a clear starting point and, hopefully, ending point in a search for ideas and information related to TETs. This does not necessarily mean a centralized facility, all in one building or under control of one organization. Such a high degree of centralization has implications for policy and mode of operations that might not provide the flexibility needed for effective TET activities. In a later section of this paper, such questions are explored within the context of a systematic approach to design for TETs.

Among the specific issues discussed below, in the design context, are questions of regional centers or of "centers" at all and questions of control and financing of TET programs and facilities. A major underlying issue is whether such TET facilities can be effectively stamped out of a common mold, with a high premium on uniformity from sector to sector, country to country, or region to region. I believe it is feasible to design them, within a common conceptual framework, but taking particular account of the special circumstances in each field, sector, country, or region for which a TET facility or network is planned.

My overriding concern with such designs is that the wide variety of TET transactions and the different needs and characterisitcs of the parties to them be dominant in the thinking of the planners, designers, and operators and that they not be confused with or lumped into the typical library or bibliographic service which is the major trend in providing technical information in many countries. Most TETs are very personal in nature, at least from the viewpoint of the recipient of the information, and often from the viewpoint of the provider; their attitudes and behavior patterns can strongly affect the success of the process.

3. AN APPROACH TO DESIGNING PROGRAMS, ORGANIZATIONS, FACILITIES, AND NETWORKS FOR TETs

For a number of years, members of POMRAD at Northwestern University have been developing an approach to organizational and program design which emphasizes the institutional realities of the situation and focusses attention on the needs and desires of the client. Although the methodology is closely related to that we use in basic and applied research on the R&D/Innovation process, the emphasis on practicality and client needs provides a different starting point from that of most of our research studies. In the design studies we start with specific indicators and measures of what the client wants to accomplish as a result of improving or initiating a design for a program or organization. We call these the "Design Criteria." For example, some criteria relevant to TETs might be:

- Increased percentage of relevant answers to questions posed
- Decreased number of search steps required by the user
- Decreased inital search time and cost
- Increased number of alternative sources of information turned up
- Usefulness of the information received
- Decreased total search time and cost
- Lower frustration level in the search process
- Successful solution to the original problem for which the search was initiated.

It is clear that some of these criteria represent immediate consequences of the TET design (e.g., initial search time and cost) and some represent more indirect and longer term consequences (e.g., successful problem solution). This range of output criteria is handled in our design procedure through the "criterion tree," which provides for causal and sequential relationships among criteria.[6]

The second concept we employ in our design work involves the "Design Features." These are factors over which the client and his associates realistically have control and which are believed to have significant effects on the level of the

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6. Albert H. Rubenstein, "Some Notes on Our Organizational Design Paradigm," May, 1975.

output criteria. For example, some design features relative to TETs might be:

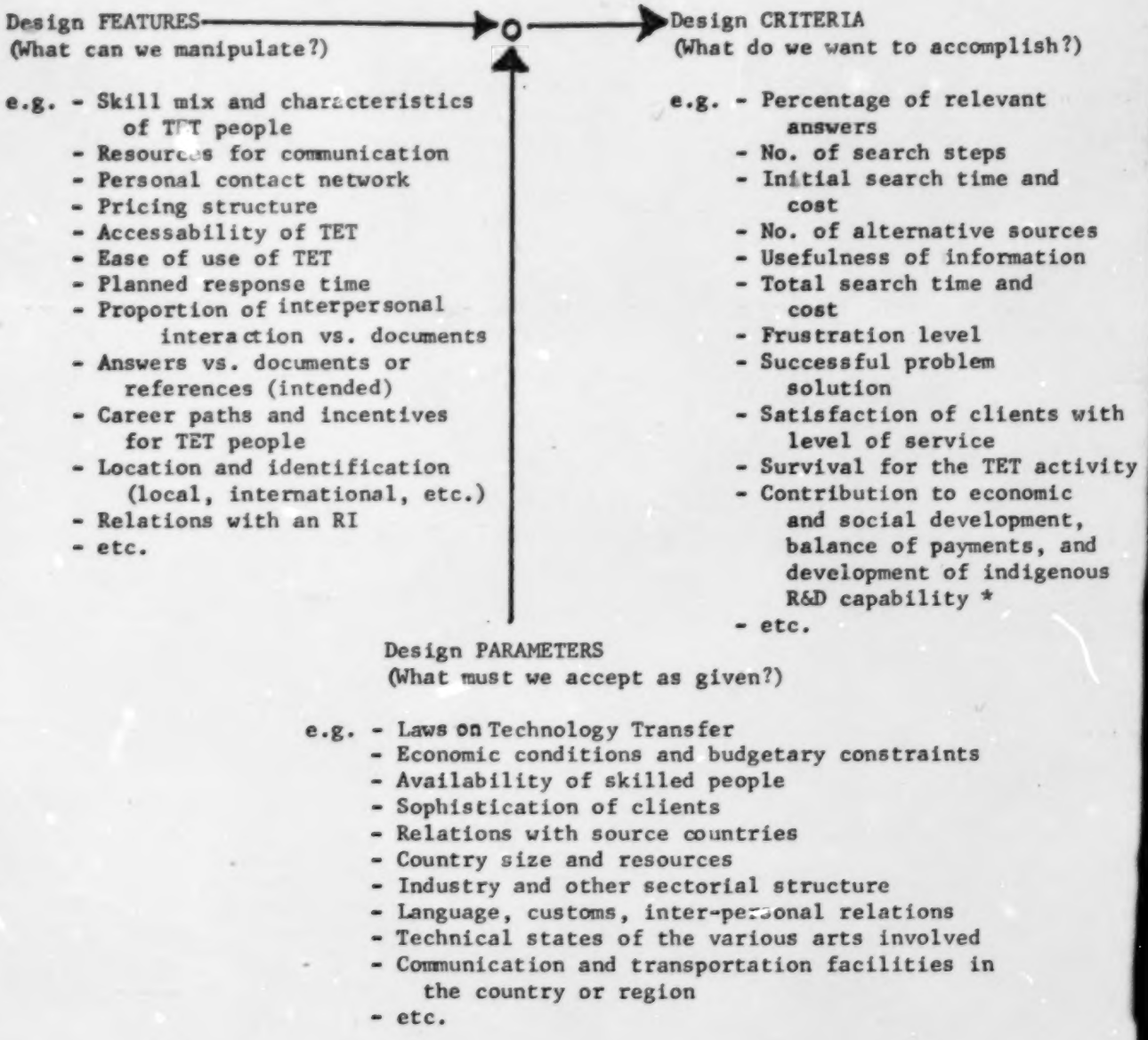
- Experience and skills of the TET contact people
- Resources for telephone, travel, correspondence, and acquiring materials
- Personal contacts between the TET people and important sources of information
- Pricing structure for information and assistance

The third concept involves "Design Parameters" or conditions over which the client has no effective control. These are "given" factors which cannot practically be manipulated in the design of the TET program or organization. Some of them (e.g., government policy) might be changed in the long run, but for the immediate purposes of designing and operating the TET facility, they must be considered given and not subject to control by the client. Examples are:

- National laws on transfer of technology
- Economic conditions in the country
- Availability of skilled and experienced people for the TET network
- Level of sophistication of TET clients in industry and government
- Existing diplomatic and economic relations with potential sources of TET information and assistance (e.g., foreign countries)

Figure 1 summarizes the design model in terms of a flow diagram, which represents what we want to accomplish, (criteria) what we can manipulate, (features) and what we must accept as given (parameters).

FIGURE 1: AN ORGANIZATIONAL DESIGN MODEL FOR TETs


Design FEATURES
(What can we manipulate?)
e.g. - Skill mix and characteristics of TET people
- Resources for communication
- Personal contact network
- Pricing structure
- Accessability of TET
- Ease of use of TET
- Planned response time
- Proportion of interpersonal interaction vs. documents
- Answers vs. documents or references (intended)
- Career paths and incentives for TET people
- Location and identification (local, international, etc.)
- Relations with an RI
- etc.
Design CRITERIA
(What do we want to accomplish?)
e.g. - Percentage of relevant answers
- No. of search steps
- Initial search time and cost
- No. of alternative sources
- Usefulness of information
- Total search time and cost
- Frustration level
- Successful problem solution
- Satisfaction of clients with level of service
- Survival for the TET activity
- Contribution to economic and social development, balance of payments, and development of indigenous R&D capability *
- etc.
Design PARAMETERS
(What must we accept as given?)
e.g. - Laws on Technology Transfer
- Economic conditions and budgetary constraints
- Availability of skilled people
- Sophistication of clients
- Relations with source countries
- Country size and resources
- Industry and other sectorial structure
- Language, customs, inter-personal relations
- Technical states of the various arts involved
- Communication and transportation facilities in the country or region
- etc.

* Of course, these are longer term, more diffuse criteria than most of those listed above, that can be directly related to the efforts of the TET activity.

4. SOME DESIGN ISSUES RELATED TO TETs

In this section, a number of issues will be discussed which constitute major policy, design, and operating issues for TET activities. Some of them should be raised at the outset, before the detailed design of a TET activity is begun. Others are, essentially, design questions that can lead to the identification of design criteria, features, and parameters for the design itself. Others are related issues that will bear on the success of both the design of the TET activity and its long term impact on its clients and the country, sector, or region in which it is located.

4.1 To What Extent Can and Should the TET Activity (Program or Organization) Be Tailored to a Specific Country, Sector, Field, or Region

There is some evidence from our informal observations and studies on research institutes in developing countries that many international regional centers for applied research and TETs may not be very effective. Some of the reasons for this may include:domination of such centers by one or more of the participating countries; differences in size, language, level of sophistication, and culture of the participating countries; geographical barriers;wide variations in economic, industry, and social structure of the participating countries.

Unlike scientific research centers (e.g., CERN) which tend to be "universalistic," technology centers tend to be more local and designed to serve particular local needs rather than the more general needs of the"scientific community." In addition, the material with which technology centers deal are often more directly linked to commercial operations and there are more likely to be proprietary or nationalistic feelings about the information and its implications for profit, national development, or competitive trade position . One way of contrasting scientific and technical communication is that the latter is more focussed, more goal-oriented and more self serving. This makes it difficult for an international center to cater to a wide variety of clients from many countries, regions, or sectors. The starting point of a TET is typically a very specific, localized need for information to accomplish a particular task. This implies not only familiarity with the circumstances

under which the task or the problem arose, but also an interest on the part of the TET personnel in helping the client to solve the problem. Although motivation for such assistance can often be universalistic, it is more likely to be tied to common interests, e.g., nationality and culture, than to a general interest in helping people from other countries. One substitute for this nationalistic self interest is, of course, a market system. Under such a system, TET personnel might be motivated to provide assistance for anyone who can pay the established prices. This may appear to be a harsh view of the motivation of some people in the TET business, but it is based on long term observations of the shortcomings of regional and international centers, where the identification of the staff with the clients is very low.

Even in the absence of a proprietary or profit motivation among the clients of TET services, there is often fierce competition and secrecy among ministries in the same country and between people in the same sector in neighboring countries. This situation even prevails among departments in the same corporation, where lack of cooperation and rivalry are observed among different functional areas (e.g., research, development, engineering, manufacturing).[7]

Certainly, there are many small and poor countries that cannot afford to "go it alone" in the TET area (or many other areas of science and technology). They cannot possibly afford the skill mix, number of people, equipment, data bases, processing facilities, etc. required of a self-sufficient TET activity. They must have some tie-in to regional, bi-lateral, or international organizations for these capabilities. These parts of the process - the "back room" parts may have to be regional or international. However, it is important, in the spirit of the comments in this section, that the "front end" of the TET process - the one in contact with the client - should be local or national, direct, and dedicated to the interests of its own set of clients and their special problems and circumstances. This front end or "switching mechanism" that I have referred to in the earlier papers can be, and generally must be, hooked into a large network of sources and special capabilities, but the direct client-TET interaction should be a local or sectorial or national relationship that clearly indicates the special dedication of the TET activity to its clients.

4.2 Design of a TET System for the Short vs. the Long Range

Historically, a lot of money (relatively) and other kinds of resources have been provided for the organizing and initiating of TET-types of activities -

7. Albert H. Rubenstein, "Organizational Factors Affecting R&D Decision-Making in Large Decentralized R&D Companies", Management Science, July, 1964.

e.g., information centers, technical assistance programs, research institutes, technology transfer mechanisms. Much of this help has come from international and national government agencies, foundations, banks, and other development-oriented organizations.

However, not much funding (in some cases virtually none) or technical assistance is provided for the necessary longer-run maintenance, growth, self analysis, modification, Research and Development, career development, travel, materials, etc. Typically, a TET project involves starting a center, program, or activity and then casting it loose to find its own continued funding and other support. This situation is quite understandable, in view of the limited funds and large number of potential "clients" of such organizations as international development banks, U.N. agencies, foundations, and other technical assistance organizations. However, this mode of operations, like giving a building to a university, with no funds for its upkeep, can be less than satisfactory for a country already burdened with a multitude of new and struggling development mechanisms and projects.

The establishment of a new TET activity on a firm financial and institutional basis often takes many years, depending on the time required for such activities as:

- establishing personal working relations with clients
- achieving an understanding of their clients' problems and operational needs
- recruiting and training of their own personnel
- establishing sound data bases and sources of information

Some of the institution-building activities required of TET organizations, if they are to contribute effectively to the national economy in the long run, include:

- developing career paths for their personnel. In some cases, this means that the TET organization faces the reality that one of its major roles is that of finding, training, and giving practical experience to people who will soon move on to better-paying, more challenging, or otherwise more rewarding careers in client organizations. This is a traditional role of Research Institutes, as well as universities and resisting it may be non-functional for both the RI itself and the country.

- attempting to develop long term funding sources or arrangements that will ensure its survival, growth, and effectiveness. This is typically a frustrating experience and has led many TET organizations into the belief that they can become self-supporting in the intermediate range through fees-for-service from clients - governmental and private. Observations over a wide range of cases in both highly developed and newly developing countries suggest that this is a futile hope. There are very few such activities in the world that attain self-sufficiency without some sort of governmental subsidy or favored treatment. This situation, of course, leads to the problem of control and autonomy, another long range problem of RIs and other TET activities.

- avoiding easy, quick "score keeping" to justify its existence and support. Such actions tend to lead to counting or measuring activities that do not really represent actual service to client, but only certain superficial manifestations of real service. Examples are: number of inquiries received and handled. Such statistics, common in the library field and in many STI activities, do not reflect actual value to the client or to the development objectives of the country; they are merely activity, rather than output measures for the TET process. In some cases they can be self-defeating, placing emphasis on "front-end" activity levels, e.g., number of inquiries "processed," rather than "down-stream" economic or social results for their clients.

- anticipating the long term institutional "niche"that it can fill in the society. Proper long range thinking and planning will often reveal that competitive organizations and services will likely arrive in the near future, some of them offered on a commerical basis. Further, such competition will even arise from their own clients, who may decide it is cheaper and more effective to build their own internal TET capability than to depend on outside organizations. Rather than the attitude that has been observed in some situations of attempting to block such competition (either from clients themselves or from other outside organizations), the TET organization will be better advised to cooperate in developing such "competition" and to continually modify its own role in the overall TET network in the country. Such a longer

term view, in which the TET organization cooperates in developing its own "competition" or successor-services, may actually lead to a more secure place for it in the national network and greatly improve its chances of survival and service to its clients. Few TET organizations in LDCs can hope to be self-sufficient in terms of data bases, special information services, special areas of expertise, etc. Every effort should be made to become integrated into the national and international TET network, rather than fighting for short term competitive position. The place of a national or sectoral TET activity can become secure primarily by becoming indispensable or at least cost-effective for its clients, and this will require offering a wide enough range of services to satisfy its clients' diverse, long term, and changing needs.

4.3 Balance of Interactive (Person-to-Person) vs. Non-Interactive TET Services Provided

This is a major issue in design of the services and operating pattern of a TET activity. There are several sub-issues involved and they will be touched on here and explored in later papers on this subject of designing TET activities.

One issue, which is far from trivial in countries with limited communication or transportation facilities, is the question of mode of communication between clients and TET personnel, in both directions. There is a vast amount of experience in this field, world wide, from the operations of public libraries (e.g., branch libraries, bookmobiles) to computerized data banks, accessible through satelite communications, wire, or other means. Our experience in many LDCs suggest that travel and communication between a client's organization and the TET location constitute major, in some cases, overwhelming barriers to use of the TET facilities. Some people view this as primarily a rural problem, where the distances and lack of ready transportation prevent clients (e.g., farmers or small-industry personnel) from reaching the urban source of information or vice versa. However, such barriers are very common in urban areas, where traffic, inadequate telephone systems, and other barriers discourage clients from seeking or using the help of TET organizations. The prospect of a long and (potentially hazardous) automobile trip across a huge city to meet

with TET personnel or to try to find a document (that may not be there) have been observed to be a major deterrent for many potential users of TET services. Add to that the uncertainty of finding the TET person available upon arrival at his or her office, the often long waits to confer with them, and the low probability of ultimate success in filling the need for TET information, and the barriers of travel and communication are far from trivial. Some of these barriers are particularly aggravating with respect to international regional TET centers, where travel papers and official arrangements have to be made even for a quick trip for consultation or searching for particular material.

But perhaps the dominant issue in this area is the over-riding question of "information or answers" vs. "documents or references." Even in most highly developing countries, the issue is far from resolved and it is under study by a number of U.S. agencies (e.g., NASA, ERDA, - the space and energy agencies - and the National Science Foundation). For most of the kinds of problems and requests initiated by clients in LDCs and smaller organizations in developed countries, a document may be of low value in answering a question. A bibliography may be of even less value. Neither may be of much help in solving a special TET problem which needs a specific answer ("should we or shouldn't we do it," "can we or can't we do it this way," "where can I get a definitive answer to this question or problem," etc.). In addition to the fact that the vast majority of practical TET questions raised by LDC clients are not covered, let alone answered in formal literature, the following problems affect the actual use of documents, when they might actually be useful or applicable:

- cost and time delay in getting the hard copy of a document
- available time and internal capability in the client's organization to read the document
- ability to interpret and apply the information in the document

For the non-sophisticated client of a TET organization in most LDCs, the real need is for: hands-on, face-to-face consultation with an "expert" or at least a specialist who can"see" the problem, consult with and interact

with the client, and give assurances (hopefully truthful) that the problem is solvable within the time and financial and effort limitations of the client organization.

The most pressing need in TET assistance is for human contact (not necessarily face-to-face if costs or distance and time do not permit it) to,among other activities:

- interpret and analyze the problem or question
- guide and actively help in gaining access to sources of possible answers or help
- formulate a search strategy and adjust it, as the search progresses
- introduce the client to specific high probability sources -- e.g., "I suggest that you call Mr. Smith, I have already told him about your problem", or "Why don't you and Mr. Smith and I have lunch to discuss your problem", (a typically North American arrangement.)
- estimate the cost, time, effort, and other consequences of the search and the expected outcomes

These activities strongly suggest, as pointed out in the earlier papers, the need for "linking" or "switching" roles in the TET organization. These are more than just the traditional"information gatekeepers" who know where the information is likely to be (they are often wrong, by the way). These are people who take an active interest in the client's problem and circumstances, participate with him in the search, follow through, and make every effort to achieve a fruitful ultimate outcome of the search.

There are such people in many organizations and countries. Their roles are culture-bound and depend heavily on the reward system and the interpersonal-relations aspect of the culture of the organization,the field, and/or the country. In some places they are considered "busy-bodies" who would rather poke into other people's problems and affairs than do their own work. In other circumstances they are highly valued and rewarded for this kind of activity.

Such roles,in my opinion, constitute the key to success of TET activities and, without them, such activities can degenerate into sterile document-furnishing organizations which do little to help in solving real problems for their clients or their country.

4.4 Can and Should TET Activities Stand Alone or Should They Be Integrated With an R&D - Performing Organization

"Full line", effective TET activities should have the whole range of resources required for successful assistance to clients: "know-what" information, "know-how" information, "know-why" information, and "know-who" information.

Many of the questions that clients raise are not merely information questions; they involve the judgement of someone whose opinion and competence they respect. They need informed opinions (backed up by experience and good analytical reasoning) on such issues as:

- where is the best place to buy this equipment
- can I trust this seller of equipment, products, or services
- what risks am I running (delay in shipment, long set-up and start-up times, rapid obsolescence, high operating and maintenance costs, getting replacement parts, credit terms, etc.)

What I am suggesting is that the relation of a "full line" TET organization, the kind that will be most useful to the most clients in LDCs, is, indeed, a client relation, rather than an arms-length information supplier, who takes no responsibility for actually solving a problem or achieving ultimate beneficial results from the search. This is a very difficult capability to achieve in an LDC, or even in a highly developed industrial country. However, for the long run success of TET activities, I believe it is the situation that should be sought and designed for. The above requirements suggest that an effective arrangement in many cases might be integration of the TET activity with a broad-range or sectoral research institute (RI), where one exists in the country. In the former case, the broad range RI should have a broad and deep science and technology base with: laboratories for product, processes and material testing; pilot plant facilities for product and process development; a capability for feasibility and techno-economic studies; a staff of experienced application engineers who are available for travel to client sites; legal and patent people; and a broad network of national and international contacts. Of course, this ideal organization does not exist in many countries. In some cases, there is a sector-specific RI (e.g. agriculture, mining, food industry) which can supply these capabilities for its own sectoral clients. In many other cases, such RIs have yet to be initiated or fully developed. Where such an RI already exists, or is in the process of development, the synergism between the RI and the TET activity can be mutually beneficial. It can help both

to survive and to better serve their clients and country. One situation that I have observed in several countries has disturbed me, however, and can seriously reduce the effectiveness of the RI/TET combination in the long run or even in the short run.

This is the tendency on the part of some governments to mix the service-to-clients role of the RI/TET and the role of regulation or watchdog over clients. This is a combination that can violate the basic rules and spirit of client-RI/TET relationships and cause a relationship to break down or be less than effective. There is some evidence that potential or current clients in some of these countries are looking with suspicion and displeasure on the role of an RI in screening, advising the government on, or even deciding on requests for equipment and technology import licenses. This can put the RI and its client in an adversary relationship, rather than the trusting, partnership relationship that a service organization tries to establish with its clients. I believe it can defeat the purpose of a RI or TET organization to be put in this ambiguous position. On the one hand, the RI is supposed to protect and advance the specific interests of the client (almost a "sacred" role in many professional-client relationships). On the other hand,that same RI may be transmitting client secrets or information to government or other agencies and/or subordinating the clients' interests, even though the overall intentions may be for the national good. Whatever the ethical aspect of this ambiguous situation, it can, from a practical viewpoint, harm the trust relationship between RI and client and greatly interfere with the development of the RI and its overall contribution to the national goals.

Aside from this specific issue, there is the need for the TET activity not to be compartmentalized within the RI, if it is to be integrated with an RI. Using the STI activity in some RIs as an example, I have observed that many of them are relatively isolated from the main-stream activities of the RI, including the laboratory people and the field technical assistance people. Where this is the case, STI is less effective than it might be, and the quality of STI provided to clients is quite limited. In the case of a full-range TET activity, such isolation from main stream RI activities would be self-defeating and the TET might as well be in another organization or place. The need is for an easy,

open flow of people, information, and ideas within the RI and between the RI, including the TET activity, and its clients. My observation has been that RIs and their associated information activities which are built and operated on the classical "separatist" university model do not provide effective service to their clients and are also wasteful of human and other resources.

I see the future of RIs and TET activities closely related. This is, in turn, related to my projection that applied science and technology performing organizations, in the future, will shift away from the heavy concentration of effort in laboratory-experimental work that now characterizes them, with only auxiliary status accorded to STI and other TET activities, and will transform into primarily information-acquiring and transforming organizations, with reduced emphasis on original laboratory work that has often been done already or is currently being done elsewhere. This anticipated trend is related to many general factors in the overall R&D field and particular ones in the field of STI and TET. Among them are: the increased cost of laboratory work in R&D; the high rate of duplication in applied R&D; the rapidly improving mechanical ability to collect, organize and provide information; improved computer analysis and design methods (e.g., computer-aided design and the many computer methods of performing automatic analysis); and the increasing need, especially in the LDCs, for adaptive technology which often can best be done in the field, rather than the laboratory.

4.5 The Need for Training, Experience, and Good Working Relations Within the Combined RI/TET Organization

The previous section was primarily concerned with the relations between the RI/TET organization (assuming the existence of such an integrated organization) and their clients. In this section, I want to touch, briefly, on some matters of internal concern to the organization itself. I have observed a large number of situations where the people in the TET area of an institute - STI, patents, license, technical assistance, and related activities - are considered separate from (and in many cases inferior to) the professional scientists and engineers who do the laboratory work in the RI. This is an unhealthy situation and leads to lack of cooperation and respect, to the disadvantage of both the RI and its clients.

Although it is clear that the kind of training and initial experience required for TET activities may be different from that required for laboratory R&D work, these initial differences should not serve as barriers to effective team work and cooperation. The integrated type of activity described in the previous section suffers in the face of rivalry, separativeness, and lack of cooperation. One way of overcoming such problems is a continual effort, on the part of the managers of the RI and its component divisions, to bring the TET and laboratory people together in joint projects and other activities as part of the normal routine of the organization. By setting up project teams that formally include members from the TET activity, direct internal benefits can be realized, as the laboratory and project people learn the advantages of having experienced TET people working with them. Such cooperation may also improve the image of the RI in the eyes of the client, as they see an integrated effort, aimed at helping him in a wide variety of ways related to his problems and circumstances.

In addition to formal client-centered projects, members of both the TET and laboratory activities can help each other gain experience and judgement in areas such as:

- techno-economic analysis
- market research
- selecting equipment and materials
- negotiations for technology acquisition
- in-plant operations (where most of the problems arise that lead clients to call the RI or TET activity)
- technology forecasting and assessment
- the whole range of related activities that are in the intersection between science, technology, economics, law, and management.

Both groups need continuous exposure to each other and to client problems that involve both kinds of specialties. They also need exposure to government agencies and foreign sources of technology and the regulations and procedures surrounding their acquisition and application. But most of all, they need mutual respect and trust of each other. Some RIs have found that TET activities can be a major help to them in their marketing of projects to potential and actual clients. They can provide quick, inexpensive, direct entree, and can rapidly help to establish confidence in the client's mind about the usefulness of the RI. Providing information or advice in the TET area can be much quicker and easier than solving a technical problem through laboratory

work of a longer term nature.

4.6 Financial and Economic Aspects of the TET Process

A major set of issues discussed in the two previous papers related to the economic aspects of costing, pricing, and selling of TET services to clients. The three concepts of cost, price, and value lead to confusion in many fields, especially those where non-tangible commodities such as information are being transferred.

RIs or other TET organizations can seldom say, with any degree of certainty, what the full costs of a particular service or transaction are. Such costing is complicated by fixed, variable, and semi-fixed costs and the difficulties of measuring and allocating each of them to a particular transaction. Pricing is also complicated by the lack of a tradition of pricing of information in LDCs, as well as in many sectors of the economy of highly industrialized countries. Finally, the value of the transaction to the client is hardly taken into account by publicly-supported TET organizations, although it is traditional in some areas of the private sector for the supplier of important information to share in the fruits of it. This applies to such transactions as those involving license fees, consulting services, or finders fees. The value of a document, piece of information, or bit of advice provided by a RI or other TET organization in an LDC, especially if they are publicly supported, seldom influences the price charged for it.

If LDCs are to benefit from the full range of TET services available and potentially available to them and to build such capabilities internally, some consideration will have to be given to all three attributes of a TET - cost, price, and value to the receiver. This will take some profound thought, analysis, and policy making, if the TET process is to approach the status of self-support, through obtaining a price for its "product" and a fair return on its investment in developing a data base, network, and capability of answering TET questions.

If the RI/TET organization is to be tax supported or substantially subsidized over its lifetime, then the questions of "fair share" of the returns to its

clients, as a result of the RI/TET contribution,may be less relevant. If, however, the concept of a self-supporting RI/TET activity is part of the national objectives, then this major source of long-term income, directly related to its contribution, should be considered seriously. Although I raise this issue in the context of the combined RI/TET, it is also a crucial matter for RIs alone and TETs alone, as well as for the R&D and STI departments of industrial companies or government agencies. Questions about the value of, support for, and returns from such activities has become very common in most countries and sectors in recent years.

4.7 Who Dominates the TET Activity

Since STI activities are the most common and familiar component of the whole range of TET activities, it might be well to consider the relative dominance of different specialties and conceptual approaches in that part of the TET process. In most STI systems, whether national or international, public or private, the design of such systems is increasingly coming under the influence of computer enthusiasts, as compared to the previous dominance by librarians. In a more general sense, the new diffuse specialty of "information scientist" or "information specialist" is being called upon to design and operate STI and related systems. From the viewpoint of the technical capabilities of equipment, software, and information sources, these people should certainly be heavily involved in both design and operation of STI systems. But from the viewpoint of the needs, desires, limitations, frustrations, and capabilities of the users of such systems, much more input is needed in both design and operations from technical people - scientists, engineers, technicians, and managers - who are the beneficiaries (sometimes the victims) of STI and TET systems.

This is a very controversial and large subject and one that I have commented on elswhere. I mention it here only because in recent months I have seen several new national STI and related systems being conceived and designed by the former two groups - the computer and library people - with only peripheral inputs from the ultimate users - the technical people.

5. HOW TO GET STARTED ON SYSTEMATIC DESIGN OF TET ACTIVITIES

Design of TET activities, in the spirit of the discussion in this paper, is not merely a matter of policy-level discussions and the bringing to bear of direct personal experience of a number of committee members - a procedure very common in these matters. It also involves a serious job of analysis and empirical investigation to determine the resources and limitations in the situation, the feasible alternative designs, and above all, the needs, desires, and characteristics of the users. I am not advocating, in this instance, turning the design of every TET activity into a basic research task to be undertaken by university personnel in the style of "research-on-research". However, many of the data-gathering and inferential methods required for effective organizational design of TET activities require similar investigation and analytical techniques to those used in research on the subject. This requirement suggests that people experienced and skilled in such techniques be involved in the design activity and that they draw heavily from the research literature on the subject, so that the design will reflect the best theoretical as well as practical thinking and experience that is available.

From the viewpoint of mechanics, I suggest that the design effort start with a task force made up of both specialists in the design and operation of TETs (the information specialists, computer people, librarians, field technical assistance agents, patent and legal people, etc.), and substantial representation from the user or potential user population (the working technical people as well as their managers). In particular, these users should be representative of the broad range of potential user groups, including the extremes in sophistication and current use of TET services. The task force, in its role of back-up advisory group to the design group described below, should also have representatives from RIs, government regulatory agencies, data system suppliers, import agents, and manufacturers representatives.

This, potentially large, task force should be in support of a small design group which will work intensively on the actual design of the TET activity

as their major activity for a concentrated period. A very common approach to information gathering in design of TET activities is to "conduct a survey". I am in favor of that, except if the survey becomes a substitute for the design activity, rather than an adjunct and input to it. In many situations, a survey can be done in a matter of days, with members of the larger task force meeting with or calling several colleagues in their own field or section and gathering data according to a common data format or instrument. The telephone is a very useful device for such surveys (just as it is for TET activities themselves, once confidence and an easy relationship has been established between the callers). Our experience has been that people in existing RIs, TET activities, and user organizations are very willing to chat on the telephone, even long distance and overseas, if the subject matter is relevant to their interests, and if the "interview" or discussion is sharply focussed. They are increasingly reluctant to answer written questionnaires and even to grant extended interviews in person.

Some additional "design features" of this TET design group should be that the design exercise, where at all possible, be done without outside funding, especially from outside the country, to avoid the typical involvements in red tape and delays that often accompany funding for such projects. Our experience indicates that a small design group (4-5 people) working on a part-time basis and supported by their home institutions (e.g., an RI, a government agency, a university, a user organization) can do a tremendous amount of the conceptual design work in a relatively short time (weeks, with frequent meetings or months, with less frequent meetings.) The back-up of the extended task force, representing the various parties concerned with the development and operation of the TET activity, can provide fast and useful information for the design group. In response to a possible criticism of the "fund-it-yourself" approach which I advocate, I can only say that if a country or sector is not in a position to finance the relatively inexpensive phase of <u>designing</u> a TET activity, then there is a high likelihood that it will not be able to support the TET operations themselves in the intermediate or long run. There are

many human resources which many LDCs have for designing such activities, including university and RI people who have had some experience in the field. I am not advising against the use of foreign "experts", but I am concerned about the overly-formal, overly-standardized, and over-controlled efforts I have observed (and been involved in) where outside funds are used for this purpose.

The design group, supported by the task force, should find the "organizational design approach", described in Section 3 of this paper, useful in marshalling the facts and opinions, the case studies and theories, the ideas and information generated in the design phase. An additional device which we have found useful in our design activities is use of "Design Propositions" which are credible assertions about the relations between: criteria, features, and parameters. These constitute the basic structure of the design rationale, summarizing the knowledge and beliefs of the people doing the designing and providing inputs to the choice of design alternatives. They are typically of the form: If you do "this" (design feature), then "that" (design criterion) will happen, subject to the influence of "these other factors" (design parameters). Given the criteria provided by the potential users or clients of the TET activity, the features can be generated with the help of these propositions, which summarize the state of knowledge about the subject. Some examples of such propositions, referring to Figure 1, are:

- a wide-spectrum skill mix in the TET activity will increase the percentage of relevant answers and satisfaction of clients, subject to the state of the art
- limited resources for person-to-person communication will increase the frustration of the client and reduce the likelihood of survival of the TET activity
- a proper pricing structure can provide funds for self-support of the TET activity, subject to economic conditions and sophistication of the clients

In conclusion, I make no pretense that systematically designing and operating a TET activity in the manner described is quick, easy, cheap or sure to succeed. However, based on our research and observations in this area, such an approach can have a major effect on improving its chances of survival and usefulness to individual clients and countries.

REFERENCE LIST

Marou O. C. Amorelli, "Technology Transfer in the State of Sao Paulo," Counsellio Estadual de Technolegia, Cidade Universitaria, Sao Paulo, Brazil, October 1974.

Nancy Beach, Research Priorities on Technology Transfer to Developing Countries, Report of Two NU/NSF Workshops Held at Northwestern University, May 1973, and Washington, D. C., September 1973, Vol. II, Survey of Selected Studies and Research on Technology Transfer to Developing Countries, published July 1974. (Doc. No. 74/61 Rev.)

Alok K Chakrabarti, "Role of Champion in Product Innovation," California Management Review, Winter, 1974. (Doc. No. 72/29).

Alok K. Chakrabarti, Albert H. Rubenstein, "Interorganizational Transfer of Technology: A Study of Adoption of NASA Innovations," to appear in the February 1976 IEEE Transactions on Engineering Management.

William A. Davig, The Transfer of Production Technology to Brazil: A Study of Two Industrial Sectors. A Ph.D. Dissertation, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois, June 1974. (Doc. No. 74/31.)

Carlos Davila, "Technology Acquisition and Employment: A Research Study in Colombia," Department of Industrial Engineering, University of the Andes, Bogota, D. E., Colombia, paper presented at The Institute of Management Sciences and the Operations Research Society of America, San Juan, Puerto Rico, October 1974.

Joseph DiSalvo, ARAC, Final Five-Year Report, Experiment to Transfer Technology from a University-Based Center, Aerospace Research Applications Center, Indiana University Foundation, Bloomington, Indiana, February 1968.

James E.Freeman, Albert H. Rubenstein, The Users and Uses of Scientific and Technical Information: Critical Research Needs, University of Denver Research Institute, Denver, Colorado, November 1974. Report of a workshop sponsored by the Office of Science Information Service, National Science Foundation, in Denver, November 1973.

James E. Freeman, "Improving Technological Information Exchange with Developing Countries, A Feasibility Study on the Progressive Establishment of an International Information System for Technology Transfer and Assessment," Phase I, report prepared for the Office of Science and Technology, Department of Economic and Social Affairs, United Nations, January 1975, Denver Research Institute, University of Denver, Denver, Colorado.

Pierre Gonod, New Challenges for Technology Transfer, Worktech Report No. 1, Control Data Worktech, Inc., Minneapolis, Minnesota, May 1975.

Daniel L. Kegan, "Creativity, Control, and Power: An Action Research Proposal for Facilitating R&D Innovation," Program of Research on the Management of Research and Development, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois, January 1973. (Doc. No. 75/68.)

Jinjoo Lee, Contract Research and Its Utilization in a Developing Country: An Analysis of Factors Influencing the Transfer of Industrial Technology from Korean Institute of Technology to its Clients. A Ph.D. Dissertation, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois, June 1975. (Doc. No. 75/63.)

Lockheed Retrieval Service Information Systems Laboratory, Lockheed Palo Alto Research Laboratory, Palo Alto, California, Dialog, Terminal Users Reference Manual, Volume I.

Ernesto Quinones Martin, "Techniques Used by the Technical Information Center in Technology Transfer," Technical Information Center of Puerto Rico, University of Puerto Rico, Mayaguez, P. R., paper presented to The Institute of Management Sciences and the Operations Research Society of America, San Juan, Puerto Rico, October 1974.

National Aeronautics and Space Administration, Biomedical Application Teams, Washington, D. C., 1967.

Organization of American States, Programa Regional de Desarrollo Cientifico y Tecnologico, Departamento de Asuntos Cientificos, Secretaria General de la Organizacion de los Estados Americanos, Produccion, Transferencis y Adaptacion de Tecnologia Industrial, Estudios Sobre el Desarrollo Cientifico y Tecnologico, No. 11, Washington, 1974.

Surinda Patel, "Unctad and the Transfer of Technology," Transfer of Technlogy Division, UNCTAD, Geneva, Switzerland, July 1975.

Barbara Peters-Koehler, Albert H. Rubenstein, Charles F. Douds, "A Behavioral Study of International Technology Transfer Between the United States and West Germany," Research Policy, Fall, 1973. (Doc. No. 71/92.)

Albert H. Rubenstein, Richard W. Trueswell, Gustave J. Rath, David J. Werner, "Some Preliminary Experiments and a Model of Information-Seeking Style of Researchers," Proceedings, 20th National Conference on The Administration of Research, Miami, Florida, October 1966. (Doc. No. 66/31.)

Albert H. Rubenstein, William Buel, Daniel L. Kegan, Evelyn A. Moore, William C. Moor, Gustave J. Rath, Charles W. N . Thompson, Richard W. Trueswell, David J. Werner, "Explorations on the Information-Seeking Style of Researchers," in Communication Among Scientists and Engineers, Nelson & Pollock (eds.). Lexington, Massachusetts: D. C. Heath and Co., 1970. (Doc. No. 69/30.)

Albert H. Rubenstein, Gustave J. Rath, Robert D. O'Keefe, John A. Kernaghan, Evelyn A. Moore, William C. Moor, and David J. Werner, "Behavioral Factors Influencing the Adoption of an Experimental Information System," Hospital Administration, Journal of the College of Hospital Administrators, Vol. 18, No. 4, Fall 1973, pp. 27-42. (Doc. No. 71/64 Rev.)

Albert H. Rubenstein, Theodore W. Schlie, Alok K. Chakrabarti, Research Priorities on Technology Transfer to Developing Countries, Report of Two NU/NSF Workshops Held at Northwestern University, May 1973, and Washington, D. C., September 1973, Vol. I, published January 1974. (Doc No. 73/61 Rev.)

Albert H. Rubenstein, Theodore W. Schlie, Alok K. Chakrabarti, "International Transfer of Technology: Some Researchable Questions," Indian Management, October 1974. (Doc. No. 74/89.)

Albert H. Rubenstein, William A. Davig, Allen D. Jedlicka, Enrique Ogliastri, "Study of Technology Diffusion in Latin America: Methodology Phase," Final Report to the Organization of American States, Program of Research on the Management of Research and Development, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois, December 1970. (Doc. No. 74/98.)

Albert H. Rubenstein, "Idea for a Research Design or an Administrative Experiment on Marketing of Scientific and Technical Information in Developing Countries," Program of Research on the Management of Research and Development, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois, November 1974. (Doc. No. 74/121.)

Albert H. Rubenstein, "Some Notes on our Organizational Design Paradigm," Program of Research on the Management of Research and Development, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois, May 1975. (Doc. No. 75/58.)

Albert H. Rubenstein, "Technical Information, Technical Assistance, and Technology Transfer - the Need for a Synthesis." Invited paper given at United Nations/ Economic Commission for Europe Seminar on the Management of the Transfer of Technology within Industrial Co-operation, Geneva, Switzerland, July 1975. (Doc. No. 75/66.)

Albert H. Rubenstein, David Birr, "Draft of Experiment Design Package on 'Accessibility Quality' Experiment," Program of Research on the Management of Research and Development, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois, November 1975. (Doc. No. 75/101.)

Albert H. Rubenstein, Charles W. N. Thompson, Robert D. O'Keefe, "Analysis of Critical Issues in the Transfer of Scientific and Technical Information: Fifth Quarterly Progress Report." Report to the User Support Program, Office of Science Information Service, National Science Foundation, Washington, November 1975. (Doc. No. 75/103.)

Francisco R. Sagasti, A Framework for the Formulation and Implementation of Technology Policies: A Case Study of ITINTEC in Peru, International Development Research Centre, Lima, Peru, February 1975.

Theodore W. Schlie, Some Aspects of Regional-National Scientific Relationships in East Africa. A Ph.D. Dissertation, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois, August 1973. (Doc. No. 73/83

Theodore W. Schlie, "Concept Development -- The 'Know-How Information System' in the Context of the Industry Coupling Program," internal memorandum, Denver Research Institute, Denver, Colorado, March 1975.

H. Schmied, A Study of Economic Utility Resulting from CERN Contracts, European Organization for Nuclear Research (CERN), Geneva, Switzerland, 1975.

William E. Souder, Albert H. Rubenstein, "Factors Believed to Affect R&D Vitality," Program of Research on the Management of Research and Development, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois, revised June 1975. Accepted for publication in IEEE Transactions on Engineering Management. (Doc. No. 72/106.)

Charles W. N. Thompson, "Administrative Experiments: The Experience of Fifty-eight Engineers and Engineering Managers," IEEE Transactions on Engineering Management, May 1974. (Doc. No. 74/13.)

Charles W. N. Thompson, "Technology Utilization," Chapter 11 in Annual Review of Information Science and Technology, Cuadra, Luke, and Harris (eds.). Washington, D. C.: American Society for Information Science, Vol. 10, 1975, pp. 383-417. (Doc. No. 75/41.)

Charles W. N. Thompson, Richard E. Herman, "Effect on Amount and Kind of Person-to-Person Communication of Management Policies and Procedures," Program of Research on the Management of Research and Development, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois, November 1965. (Doc. No. 75/112)

Miguel Verduzco R. and Miguel Angel Marquez, "Mechanisms for Transferring and Adapting Technology to Mexican Industry," Asesoria Technica Industrial, S. A. de C. V., Mexico, D. F., Mexico, paper presented at The Institute of Management Sciences and the Operations Research Society of America, San Juan, Puerto Rico, October 1974.

Winthrop W. Wiltshire, Ph.D., "The Structure of Industry in Trinidad and Tobago and the Role of CARIRI in Transfer of Technology.", Seminar on R&D Management and Technology Acquisition and Assimilation in Latin America, San Juan, Puerto Rico, October 16-18, 1974.

Earl C. Young, "An Analysis of Factors Influencing the Decision to Adopt Changes in Production Technology in Selected Chemical Firms in Mexico and Colombia." A Ph.D. Dissertation, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois, August 1972. (Doc. No. 72/19.)